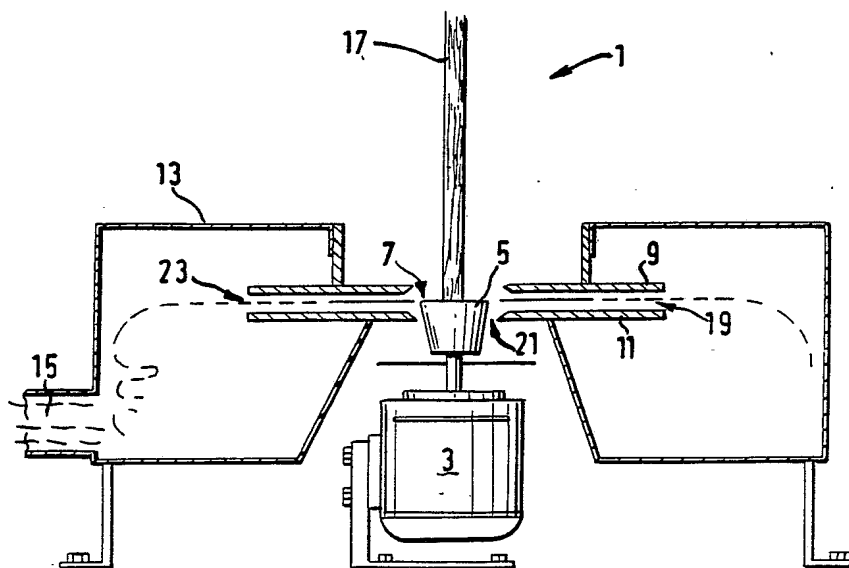




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB88/00314 (22) International Filing Date: 22 April 1988 (22.04.88) (31) Priority Application Number: 8709608 (32) Priority Date: 23 April 1987 (23.04.87) (33) Priority Country: GB</p> <p>(71) Applicant (for all designated States except US): GLASS-FLAKE LTD [GB/GB]; Forster Street, Leeds LS10 1PW (GB).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only) : WATKINSON, Charles, John [GB/GB]; 331 Leeds Road, Scholes, Leeds LS15 4DF (GB). ELVIDGE, John, Hugh, Kenyon [GB/GB]; "Applegarth", 303 High Street, Boston Spa, West Yorkshire LS23 6AL (GB).</p>		<p>(74) Agent: HARRISON, Michael, Robert; Urquhart-Dykes &amp; Lord, 91 Wimpole Street, London W1M 8AH (GB).</p> <p>(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), SU, US.</p> <p><b>Published</b> <i>With international search report.</i></p>

(54) Title: METHOD AND APPARATUS FOR FORMING GLASS FLAKES



## (57) Abstract

Flakes of glass, basalt or other frangible material are formed by feeding a stream of the molten material in a downwards direction into a rotating cup (5) which has its open mouth facing upwardly with its rim disposed at a horizontal level between a pair of spaced apart parallel plates (9 and 11) which are mounted within a vacuum chamber (13) in such manner that, as air is drawn from outside the chamber (13) between the plates (9 and 11) the molten material is drawn radially outwards without touching the plates and is cooled with the continuing outward movement causing the material to be broken into flakes.

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METHOD AND APPARATUS FOR FORMING GLASS FLAKESField of the Invention

The invention relates to a method and apparatus for forming flakes of glass or flakes of other like material.

5 The method and apparatus are applicable equally to any material which would melt when heated capable of being formed into flakes. Flakes of glass and similar materials are increasingly being used for the reinforcement of plastics or other composite materials.

10 One method which has been employed in the past to form flakes of glass has involved forming a thin walled cylinder of molten glass and then collapsing the cylinder to fracture the glass film to form glass flakes. The glass flakes produced by such a method are not flat or planar which is undesirable for many purposes.

15 A method and apparatus for forming flakes of glass was disclosed in UK Patent Specification No 1 896 71. This method is one in which the stream of heat softened material is fed vertically downwards to a rotating distributor which throws out the heat softened material onto the walls of a  
20 downwardly facing annular cup. The cup forms part of a rotor which rotates at high speed and therefore gravity and centrifugal force causes the material to flow downwards along the inner walls of the cup and then out from the bottom rim of the cup. This projects the material outwardly in

the form of a film and this film is then broken up into flakes. It is suggested that the film can be broken up into flakes by mechanical means and the specification also described a method of breaking the film into flakes by blowing gas at high pressure in a direction so that it cuts through the film to break it up into flakes. This method and apparatus has now been used for a number of years but it involved complex arrangements of heating and cooling means about the rotor and its surrounds. Moreover the glass flakes produced are often inconsistent in size and thickness.

#### Summary of the Invention

According to the invention there is provided apparatus for forming flakes of material from a heated stream of molten material comprising means for feeding the stream in a downwards direction into a rotating cup, the cup being arranged such that its opened mouth faces upwardly such that molten material within the cup is caused to flow over the upper edges of the cup and flow outwards in a radial direction due to centrifugal force, the apparatus also including a pair of spaced apart substantially parallel plates arranged about the cup such that the material leaving the cup by centrifugal force passes through a gap defined between the plates, the plates being mounted within a cyclone vacuum chamber arranged such that a vacuum is applied to the space between the plates to draw air from outside the chamber between the plates in a radial direction to prevent the molten material from touching the sides of the plate and cool the material until it reaches a solid state pulling the material in a radial direction keeping the material in a flat film and breaking it into small platelets.

Thus the molten material fed between the plate is prevented from rolling or rucking over.

Preferably the plates are in the form of two annular plates with cup mounted such that its rim lies between the plates.

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Preferably the vacuum chamber is connected via its outlet to a cyclone precipitator separator and vacuum pump.

By suitable choice of speed of rotation of the cup from the distance between the two plates and choice of air flow through the vacuum chamber the size and thickness of the flakes of material to be produced can be controlled.

Preferably the cup has tapered sides so that its top edge flares outwards so that the passage of the molten material up the sides of the cup is aided by centrifugal force.

The apparatus can be used to produce flakes of many different materials which can be molten. Typically this material will be glass but the apparatus may equally be used with materials such as basalt, ceramics such as alumina, graphite, and metals such as lead.

For each different material different parameters of speed of rotation of cup temperature or molten material volume or molten material gap between the plate and airflow between the plate will be different. It is preferred therefore that the apparatus includes means to vary many of these parameters as possible.

It is therefore preferred that the cup is attached to a variable speed electric motor which allows the speed of rotation to be varied readily.

Preferably at least one of the plates is mounted so that it can be moved towards or away from the other. Clearly by varying the distance between the plates this will also have an effect on the speed of airflow between them.

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The speed of airflow can also be varied by varying the vacuum pull applied to the cyclone vacuum chamber.

5 The produced flakes can be treated by coating with suitable bonding agents or other chemicals by injecting an adhesion promotor or chemical either as the material leaves the cup or as it leaves the gap between the two plates.

It should be noted that the diameter of the plates will also have an effect on the flake size and thickness to be produced and this also will have to be carefully chosen.

10 The variable parameters can be varied within wide ranges and all have an inter-relation on each other. The material to be used is chosen. It will be readily apparent to the skilled addressee of the specification on how to vary the parameters to produce flakes of required size and thickness.

15 Once the parameters for a particular material type and flake size are established the apparatus will produce that material constantly within very fine dimensional limits.

20 Thus, the method in accordance with the invention consists of feeding a stream of molten material in a downwards direction into a rotating cup; allowing the material to pass over the edge of the cup to be forced through a pair of plates surrounding the cup in a radial direction by a flow of air passing between the plates to pull the stream of material in a radial direction to keep it flat and also to pull it to form flakes to be fed  
25 from a vacuum chamber to a collection point.

#### Brief Description of the Drawing

A method and apparatus for forming flakes of material from a stream of molten material will now be described by way

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of example only with reference to the accompanying drawing which is a schematic section through the apparatus.

Description of the Preferred Embodiment

5 Apparatus 1 for manufacturing flaked material from a stream of molten material consists of a variable speed electric motor 3 mounted vertically to which is attached a tapered cup 5.

10 The rim of the cup 7 lies between two annular plates 9, 11, the upper one 9 of which is adjustable. The two plates 9, 11 are mounted within a cyclone vacuum chamber 13 which is connected via the outlet connection 15 to a cyclone precipitator, separator and vacuum pump (not shown).

15 The method of operation is as follows. The cup 5 is rotated at speed and the stream 17 in this case of glass, is allowed to enter from above. Centrifugal force distributes the glass evenly within the cup and pushes the glass outwards over the cup rim 7.

20 The vacuum is applied to the cyclone vacuum chamber 13 via the outlet connection 15. Air enters this chamber via the gap 19 between the annular extraction plates 9 and 11 at a point 21 on the lower plate 11 and a corresponding location on the upper plate 9.

The entering air has a dual effect on the process. The air rapidly cools the centrifuge cup 3 and the glass leaving the cup 3 at the rim 7:

25 The glass leaving the centrifuge cup 3 at 7 is located within the gap and prevented from touching the sides of the annular plates 9 and 11 by the air flow.

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The air flow continues to cool the glass until it reaches a solid state, and due to friction upon the glass, continues to pull in a radial direction, thus preventing the glass from rolling or rucking over, keeping the glass flat and breaking it into small platelets.

The platelets are collected in the cyclone vacuum chamber 13 and exit via connection 15 to a precipitator cyclone and filter section (not shown).

The size (loosely described as the diameter of platelet or flake) and the thickness of flake can be varied through a considerable range by adjusting the flow of glass into the cup 3, adjusting the speed of rotation of the cup 3, adjusting the distance between the annular extraction plates 9 and 11 and varying the vacuum pull or velocity through the gap 19 between the annular extraction plates for any given gap by varying the amount of air flow through the extraction connection 15. Thus, a range of materials can be manufactured on this equipment both in diameter and thickness without recourse to further grading, crushing or grinding operations.

The product produced is taken through the stages of manufacturing to packaging without being exposed to the atmosphere external to the equipment.

Treatment of the flakes produced by coating with suitable bonding agents or other chemicals, can easily be made by injecting such adhesion promotor or chemical at point 23, or other suitable location such as point 21 within the air flow.

A glass stream of low temperature can be extruded by the air flow through the gap 19 with considerable force, pulling it extremely thin even at low temperature. Alternately the gap 19 can be increased and the speed of the centrifuge cup 3



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increased to give different parameters for the production of flake.

5 Because the variables are wide, e.g. the volume of molten stream entering centrifuge cup 3, the temperature of that material, the speed of centrifuge cup 3, the diameter of centrifuge cup 3, the gap at 19, the distance between 7 and 23, and the air flow at 15, the process lends itself to manufacture of flake of various sizes from many different materials with varying viscosities and melting points.

10 Once the parameters for a particular material type and flake size are established, the apparatus will produce that material constantly within very fine dimensional limits.

CLAIMS

- 1       Apparatus for forming flakes of material from a heated  
stream of molten material, said apparatus comprising means  
for feeding the stream in a downwards direction into a  
rotating cup, the cup being arranged such that its open  
5       mouth faces upwardly whereby molten material within the  
cup is caused to flow over the upper edges of the cup  
and flow outwards in a radial direction due to centrifugal  
force, the apparatus also including a pair of spaced apart  
substantially parallel plates arranged about the cup such  
10       that the material leaving the cup by centrifugal force passes  
through a gap defined between the plates, the plates being  
mounted within a vacuum chamber so arranged that a vacuum  
is applied to the gap between the plates to draw air from  
outside the chamber between the plates in a radial direction  
15       to prevent the molten material from touching the sides of  
the plate and to cool the material until it reaches a solid  
state pulling the material in a radial direction thereby  
keeping the material in the form of a flat film and breaking  
it into small platelets.
- 20       2       Apparatus according to Claim 1, wherein the vacuum  
chamber is a cyclone vacuum chamber.
- 3       3       Apparatus according to Claim 1, wherein the plates  
are two annular plates and the cup is mounted so that  
its rim lies between the two plates.
- 25       4       Apparatus according to Claim 2, wherein the vacuum  
chamber is connected via its outlet to a cyclone precipitator/  
separator and a vacuum pump.
- 5       5       Apparatus according to Claim 1, wherein the cup has  
tapered sides and its top edge flares outwardly.
- 30       6       Apparatus according to Claim 1, wherein rotation of  
the cup is effected by a variable speed electric motor.

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7 Apparatus according to Claim 1, wherein at least one of the plates is so mounted that it can be moved towards and away from the other plate.

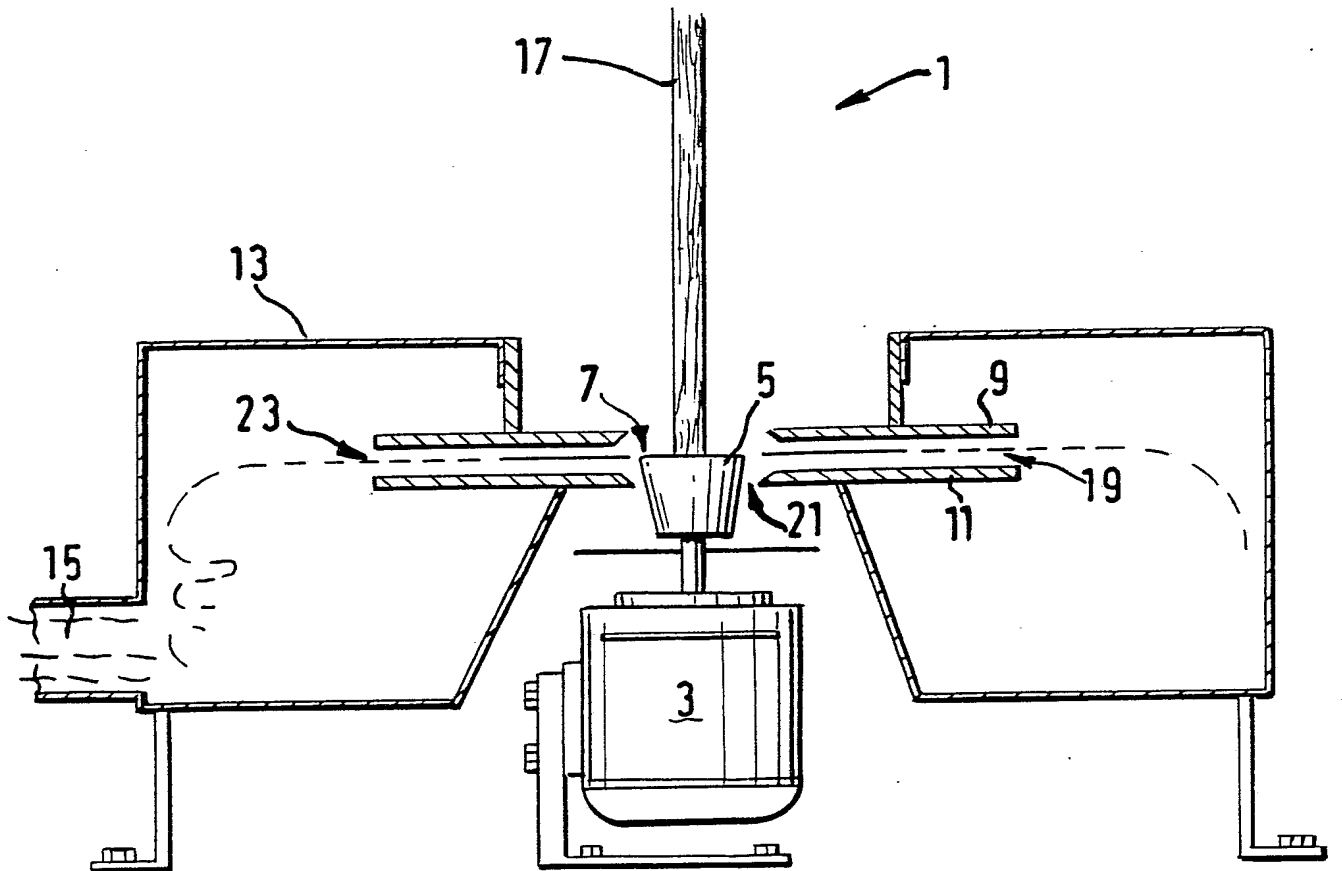
5 8 A method of forming flakes which comprises feeding a stream of molten material in a downwards direction into a rotating cup; and allowing the material to pass over the edge of the cup in such manner as to be forced into the gap between a pair of plates surrounding the cup, such movement of the material being in a radial direction and  
10 effected by a flow of air passing between the plates so as to pull the stream of material in a radial direction in such manner as to keep it flat and also to pull it so that, as solidification of the material is effected, the material is broken into flakes.

15 9 A method of producing flakes according to Claim 8, wherein the flakes are treated by coating with an additive either as the material leaves the cup or as it leaves the gap between the two plates.

20 10 Apparatus for forming flakes of glass basalt or other frangible material substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

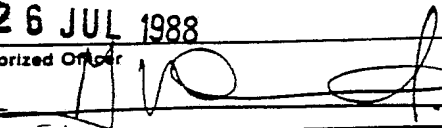
11 A method of forming flakes of glass, basalt or other frangible material substantially as hereinbefore described with reference to the accompanying drawing.

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# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00314

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>4</sup> : C 03 B 37/00		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC <sup>4</sup>	C 03 B 37/00	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A, 3257183 (SLAYTER) 21 June 1966, see the whole document --	1,2,4,5,6,8,10,11
Y	US, A, 3607165 (GUTHRIE) 21 September 1971, see the whole document --	1,2,4,5,6,8,10,11
A	US, A, 2156982 (HARFORD) 2nd May 1939, see the whole document --	1,8
A	US, A, 2338473 (PAZSICZKY) 4 January 1944, see figure 3 -----	1,8
<p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Δ" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
4th July 1988	26 JUL 1988	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	M. VAN MOL 	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3257183		None	
US-A- 3607165	11-05-71	None	
US-A- 2156982		None	
US-A- 2338473		None	